

# The National Tropical Botanical Gardens



## A Horticultural Internship

A Report by Benjamin Chester

## ACKNOWLEDGEMENTS

It must be said that the life changing experience I gained from my internship is all thanks to the organisations that provided the funding for the trip. So all of my thanks goes out to the RHS who contributed £1600 (£800 per person), The Merlin Trust who donated £750 per person and Nottingham Trent University who provided £250 through their NTU International Travel Scholarship scheme.

Huge thanks must also go out to Rowena Wilson of the RHS, Chloe Wells of the Merlin Trust and Annamay Simpson of Nottingham Trent University. These ladies showed such patience with my endless questions and were all so kind, they are all credits to their organisations.



Fig1 Allerton Beach



Fig 2 Ben Chester, Connor Deacon Kamalani Beach

Having not previously been very well travelled, thanks go out to my travel companion Connor Deacon who ensured that we actually arrived at our destination and more importantly arrived back home safely.

My most heartfelt gratitude goes to Ashly Trask, not only an amazing teacher, mentor and leader, staying with her and her extended family over the month was one of the most incredible experiences of my life and now equally regard them as my extended family.



Fig 3 Waimea Canyon State Park Camp Site

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## INTRODUCTION



Fig 4 Palms at Poipu Beach

Before starting a degree, it can feel that the next three years are going to take a long time to complete but the harsh reality is that they fly by at a phenomenal rate and it is difficult to fit in all the things you hope to gain and experience during your time at university.

Internships are an excellent way to gain new skills, experience and develop networks for future employment, the additional bonus being that they can be as long or as short as you like, giving you the possibilities to fit in various different internships whilst at university.

As my main objective was to gain as many skills and as varied experience as possible, my attention went to towards internships in botanical gardens around the world in the hope that a change of location and climate would only help the wealth of experience gained.

I soon developed communications with The National Tropical Botanical Gardens (NTBG) in Hawaii and arranged an internship for myself and Connor Deacon during winter break (7<sup>th</sup> December 2015 until 7<sup>th</sup> January 2016). This would turn out to be a rather expensive internship with flights alone averaging in the thousands. It is again thanks to organisations like the RHS, Merlin Trust and NTU that make such trips possible for people wishing to develop knowledge and skills.

This report will discuss the experiences had by myself and Connor Deacon at The National Tropical Botanical Gardens and on the island of Kauai in Hawaii, in the hope to not only demonstrate what a worthwhile experience it was, but to inspire others to partake in similar trips.

As many days were spent conducting similar tasks, the report will write about experiences based in different area and tasks as opposed to a standard itinerary or diary.

## THE PEOPLE



Fig 5 The family at Waimea Canyon State Park Camp Site

After traveling for 27 long hours, we finally arrived on Kauai at 10pm local time and were greeted by Ashly Trask who not only would be our internship coordinator, but also be providing us with housing for the entirety of our trip. Being late at night we were unable to see the landscape around us and even if we could we were certainly not coherent enough after our travels to be able to take it all in.

We were driven to Ashly's home where we met her extended family. This consisted of Ashly, her partner Jesse, their two children Kai, Sol and Freya, Jesse's sister Hollie, her daughter Bowie and two family friends Paula and Sebastian. A Mexican family with Columbian friends, we were certainly thrown into a large family environment. I can say hand on heart that were some of the nicest people I have ever met and made us feel nothing but welcome and part of the family the entire time we were there.

Staying with people who are local is an easy and efficient way to maximise your time whilst on an internship as they will generally know the best places to go, the cheapest places to go and ways to fill in your down time.

As important as this internship was in terms of horticultural and educational experience, if it were not for this group of inspirational people giving us a home and solid base to work from, learning much of anything would have been very difficult. This fact only substantiates my feeling that horticulture attracts some of the best people and characters out there, making the horticultural sector one of the best I hope to continue working in.

As for the rest of the people on the island, being American they are generally a lot more outspoken and honest about things which was kind of refreshing having lived in England all of my life. This kind of communication is perfect with regard to an educational environment and we learnt much more and to a higher standard.

This type of honesty and openness is definitely something I will carry forward within my own life, in and out of the work environment.

## KAUAI



Fig 6 Allerton Beach

Kauai is just under 24 times smaller than England with an area of 562 square miles. It is the fourth largest of the main islands of Hawaii and known as the 'Garden Isle' for obvious reasons. Although this island maybe on the small side, it's vastly changing terrain offers an even vaster area of microclimates. In terms of conservation, this island can be used as a scaled down version of what is happening and may happen in terms of climate change throughout the rest of the USA and the world.

These microclimates make for very interesting weather patterns, with one side of the island demonstrating vastly different weather to another side and going from torrential downpours to blazing sun within the space of five minutes.

Although known for being ones of the wettest places on the planet, this Island offers some of the most beautiful sights I have ever seen and hope to return as soon as possible.



Fig 7 View over Allerton Gardens NTBG

## THE NATIONAL TROPICAL BOTANICAL GARDENS

The National Tropical Botanical Gardens are based at 5 locations, four are in the Hawaiian Islands and the final one is located in Florida. With Kahanu Garden on Maui and Limahuli Garden and preserve located away from us on the North side of Kauai, our internship was based in and around the Allerton and McBryde Gardens of the NTBG in the Lāwa`I Valley.

Located in the only tropical climate zones in the United States it is the National Tropical Botanical Gardens mission to cultivate and preserve a broad range of tropical plants.

'Hawaii is the world's most isolated land mass. It is so remote that a seed or spore reaching here by wind, bird or ocean current took hold only about once every 30,000 years.

Then humans arrived, bringing a host of aggressive plants and animals. Native species were defenceless.

Today, 100 of 1000 known native species have disappeared and more than a third are considered endangered or rare. In an attempt to survive, these plants often cling to precipitous cliffs inaccessible to pigs and other introduced menaces.

'It is a race against time to find, protect and propagate these plants on the brink of extinction' (taken from a sign in the educational centre of the NTBG)

It is thanks to the dedicated team and their many volunteers that this non-profit organisation can carry out such important work and I am glad to have been a part of it.



Fig. 8 Allerton Gardens NTBG

ALLERTON GARDEN



Fig 9 Allerton Beach



Fig 10 View from Allerton Beach to Queen Emma's Cottage



Fig 11 Queen Emma's Cottage



Fig 12 Walking through Allerton Garden

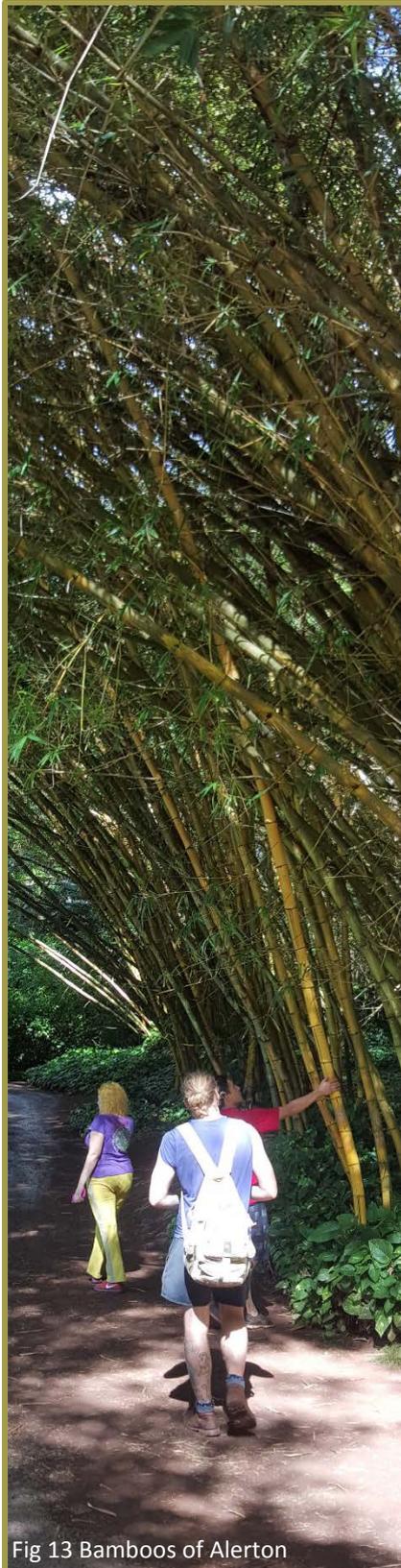


Fig 13 Bamboos of Allerton



Fig 14 Mermaid Room



Fig15 Morelton Fig Trees

Allerton Garden is found between the Pacific Ocean and the McBryde Garden in the Lāwa`i Valley. The garden is comprised of a series of garden rooms with water being heavily featured in the forms of streams, pools, miniature waterfalls and fountains.

MCBRYDE GARDEN



Fig 16 Gardenia latifolia

**The perfect botanical toolkit:**  
tubers for food, palm fronds for roofs, nut oil for light, wood for drums, leaves to heal, and bananas for their sweet taste.

The plants in this garden are "canoe plants," a set of nearly 30 plant species that the early Polynesian settlers brought with them to Hawai'i in canoes.

As they set out on the voyage they didn't know what they would find or how long it would take. But they did know that they would need to start growing things as soon as they landed somewhere new.

Space was tight in the double-hulled canoes—every plant mattered. Most of the canoe plants filled multiple needs, or they provided an essential everyday food. The plants supplied all the basics for starting a life: food, shelter, clothing, and medicines.

**How and why did they bring these plants?**  
Polynesians carried the canoe plants in the hull of the canoe on seeds, in bark, roots, and tubers. The Hawaiian plants that were on the islands before people arrived were only in grassland areas. The canoe plants changed the land into a lush forest, a place of many stories.

**Early Hawaiian Agriculture**

**Some facts:** If a canoe landed on a new island, Polynesian settlers brought with them a variety of plants, including taro, banana, and breadfruit.

**Some facts:** If a canoe landed on a new island, Polynesian settlers brought with them a variety of plants, including taro, banana, and breadfruit.

Fig 17 Educational Sign



Fig 18 various tree species

**'Alula or 'Ōlulu**  
*Brighamia insignis*  
Campanulaceae

Perhaps more than any other native Hawaiian plant, the 'ālua has become emblematic of conservation efforts to rescue critically endangered plants in Hawai'i. NTBG botanists suspended themselves over high sea cliffs to collect seeds from the last known wild plants. Back in the garden, plants were hand-pollinated, successfully yielding hundreds of new plants, preventing its complete extinction. Often described as a "cabbage on a bowling pin," 'ālua is admired for its tubular yellow flowers.

Fig 19 Educational Sign



Fig 20 *Caesalpinia ferrea*



Fig 21 *Fagraea berteriana*



Fig 22 McBryde Waterfall

If The Allerton Garden is the beauty, then The McBryde Garden is most certainly the brains. What it lacks in design, it more than makes up for in education and spreading the message of the importance of conservation containing the largest ex situ collection of native Hawaiian flora in existence.

## THE PLANT NURSERY



Fig 23 Shade area of plant nursery

In the same way that the kitchen is thought of as being the heart of the home, the plant nursery is certainly the heart of the NTBG. At the start of every working day, morning meetings are held between management and the rest of the team to outline the goals for the rest of the day before heading off to the various parts of the gardens that require work. The nursery is also where the majority of volunteers carry out the various tasks lead by Ashly Trask, the nursery manager.

The nursery really is a hive of activity with management, staff, interns and volunteers all working towards the same goal and more importantly, enjoying doing it too.

The nursery consists of the greenhouses, the shade area, a quarantine zone, the fern lab, offices, eating area, storage and preparation area and is the epicentre from where all other activities within the gardens occurs.

With working for the nursery manager, this is where the majority of our time was spent with no shortage of things to do.

With hot temperatures, a lot of sun and heavy rainfall, there are ideal growing conditions for weeds in the nursery and if a keen eye isn't kept on the situation, it can easily get out of hand. Although not opposed to herbicides, it is the belief of Ashly Trask that if the situation can be resolved easily by a bit of weeding, then that is the best option. To this end, many hours were spent conducting 'invasive species removal.'

Other tasks were propagation, potting up, planting, cleaning, digging, counting and teaching.



Fig 24 View of Nursery and offices



Fig 25 *Brighamia insignis*

This is 'Alula', the Hawaiian common name for *Brighamia insignis* which is just one of the endangered species at the NTGB. With succulent stems with dense rosettes of leaves at the top, this is one of the more unusual members of Hawaiian flora. Many of the populations of this species no longer exist. Thanks to the work of the NTGB, there are many of them in cultivation which can eventually be planted out in suitable habitats but at present there is only a single plant that remains in the wild.

Here we see me pruning off dead damaged and diseases leaves from these endangered ferns. Sent from Estonia, these small ferns have gone through a lot of stress which is shown in the loss of leaves from the plants. At this delicate stage they will need a lot of care and attention to ensure the development of fresh new growth. The removal of all the unwanted material was a detailed and precision task as many of the plants were still very small and has certainly developed our keen eyes and cutting precision.



Fig 26 Me tending to the new arrivals



Fig 27 Connor Cleaning walkways

A well-managed plant nursery should always have a focus on hygiene and maintenance. At the NTGB they have a very good routine of all pots and trays being washed in a chloride solutions before being reused. This can be a particularly mindless task but sometimes that can come as a welcome break and is without doubt an important procedure to carry out. Here we see Connor cleaning the walkways in the shade area of the plant nursery. Due to the shaded environment and water misters spraying at ten minute intervals, a problem with moss causing a slippery surface can develop which must be addressed for obvious health and safety issues.



Fig 28 Myself moving 'uala plants

One of the best and most cost-effective ways to increase plant populations is by propagation. In the picture I am propagating succulent cuttings into pots filled with a mix of compost and cinders. The pots were then placed under mister units to keep moist. The climate in Hawaii is such that it just makes things want to grow, so propagation of plants is very successful.



Fig 29 Propagation of succulents



Fig 30 Connor with *Heteropogon contortus*

The role of the nursery is to grow native and endangered plants so that they may be planted out in suitable habitats in and around the island. Here I am moving 'uala (the Hawaiian name for sweet potato) to be picked up by the grounds team so that they can plant them at newly extended visitors centre.

Other methods of increasing the plant populations are by planting seeds. Here we see Connor placing layers of *Heteropogon contortus* onto trays of cinders so that when watered the seeds are released and germinate. The seeds of *Heteropogon contortus* have long fine tapering hair-like structures which react to moisture in the air causing it to coil and straighten. This reaction can be dangerous to animals as the seeds become entangled in their fur, and work their way through the skin. Therefore caution must be taken so that there are no seeds upon you during the process or on completion.



Fig 31 Psyrax odorata seeds

In order to check success rates of seed germination and general viability, seeds must be counted out before sowing. With seeds such as those of *Psyrax odorata*, that task is rather easy, but with the smaller seeds it can become rather difficult and ends up becoming more or less a 'guesstimation.' A test of concentration and patience.

The nursery at the NTBG also had a large glasshouse where many of the seeds trays were placed to germinate in this protected environment. As with the rest of the nursery, there was the ongoing task of keeping on top of weeding and hygiene. Rows are placed rather close together to make the most of the available area which at times became a logistical nightmare when carrying large trays or pots as you also had to be aware of the irrigation systems set up around the tables.



Fig 32 Glasshouse of the NTBG

One of the more laborious tasks that we completed during our internship is something I regarded as an intern rite of passage. The digging out of the irrigation ditch was definitely something to remember and one of the more difficult jobs we did during our internship. If the baking sun wasn't enough to get us hot, then digging out piles of soaking clay certainly was. It took a lot of team work (and a lot of drinking water) to complete this task which was undeniably satisfying but more enjoyment would have been had with myself not slipping on the clay and falling into the ditch a grand total of three times (much to the amusement of Connor Deacon). Safe to say the showers at the NTBG came in very handy that day.



Fig 33 Irrigation ditch before



Fig 34 Irrigation ditch during



Fig 35 Irrigation ditch after

## THE HERBARIUM



Fig 36 Connor viewing the Herbarium display

With over 74,000 specimens of flowering plants, gymnosperms, ferns, fern allies, fungi and bryophytes, the herbarium at the NTBG is a reference collection of permanently preserved and pressed plant specimens.

These collections are of great importance as they serve for a number of purposes including, being a proof of identity for floristic and systemic studies, providing material for research on DNA, anatomy and other plant characteristics, documentation of population locations and establishing conservation priorities.

If the plant nursery is the heart of the NTBG then the herbarium is without doubt the brains.

Due to the nature of the contents of the herbarium, it must be under strict climate control. Much to our delight, this cool and dry environment was a welcome relief at times from the heat of outside.



Fig 37 Dried moss *Pogonatum taitense* Schimp. Ex Besch collected in 1996

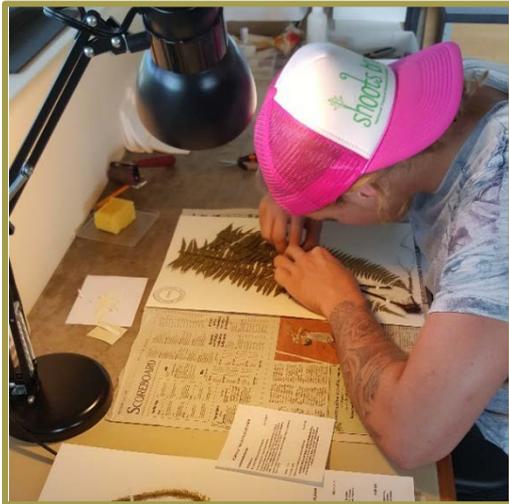


Fig 37 Connor making a voucher for a fern

Given a tour and talk about the history of the herbarium at the NTBG and the work they do, Tim Flynn, the herbarium collections manager, walked us through the processes of making the specimen vouchers (a pressed plant sample deposited for future reference) before setting us the task of making our own. The mentality of this task was that it was better to spend all day and make one quality voucher than make many vouchers to a lower standard.

Here is a picture of my first ever plant voucher which I was very proud of. Once you have figured out your layout, the specimen is held in place with a sticky tape and/or by sewing it to the card. Here I have used a mixture of the two so that a minimum amount of the specimen is covered up. Each voucher has a reference number in the top left hand corner, a barcode, an identification label showing details such as species and where it was found, a specimen and an envelope which contains any small fragments of the specimen that have fallen off. It is important to save every last piece as it all contains genetic information.

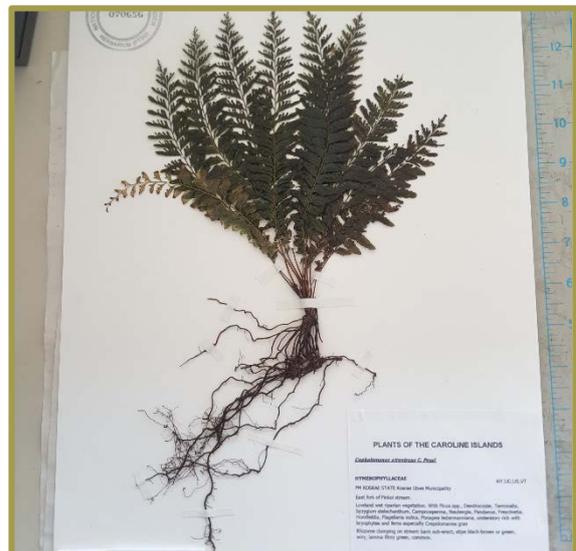


Fig 38 Plant voucher for *Cephalomanes atrovirens* C. Presl



Fig 39 *Sphagnum wheeleri* Müll. Hal.

Many of the smaller specimens, such as the bryophytes, are simply held within a series of envelopes.

Making specimen vouchers was an incredibly therapeutic task and although a long and delicate work, it was very satisfying work and have learnt new skills from it.



Fig 40 *Haplohymenium triste* (Ces.) Kindb.



Fig 41 *Thuidium cymbifolium* (Dozy molk.)



Fig 42 *Thuidium cymbifolium* (Dozy molk.)



Fig 43 *Taxiphyllum laevifolium* (Mitt.) W.R. Buck



Fig 44 *Vesicularia perviridis* (Angstr.) Mull. Hall.

## THE BIODIVERSITY TRAIL

The biodiversity trail in the McBryde Garden of the NTBG is designed to tell the story of how plant life has evolved over the past 450 million years.

The trail starts with a shaded mist tunnel filled with my favourite plants, mosses with signage explaining how these simple plant forms established themselves 450 million years ago.

Moving forward (10 million years), the trail makes space for ferns, showing how plants are becoming more complex further leading on to cycads and early palms as visitors travel further through time. The trail also tell the story of mans impact upon plant life and explains the importance of conservation.

Considering the trail was only finished in August of 2014, I was somewhat disappointed in the general appearance of it. There had been an issue with the timer on the misting unit of the moss tunnel which had led to a large portion of the mosses drying out and turning brown, not a good first impression. There was also a weeding problem which stemmed from a lack of man power being spent on the area and many parts seemed just generally untidy. As this is a relatively new installation designed to educate and draw people in, I can't help but feel more attention should be assigned to the trail.

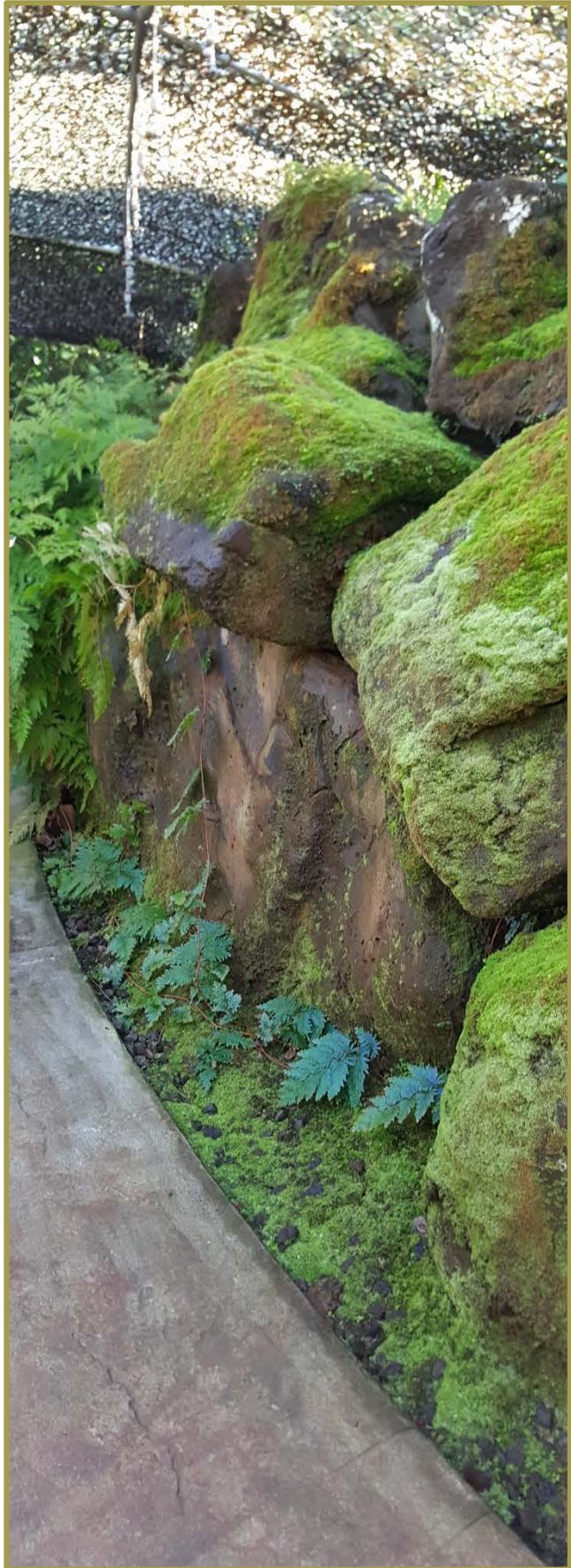


Fig 45 Mist Tunnel of the biodiversity trail



Fig 46 Mist tunnel of the biodiversity trail



Fig 47 Hanging orchids of the biodiversity trail



Fig 48 Moss tunnel of biodiversity trail



Fig 49 Educational Signage of biodiversity trail

## THE FERN LABORATORY



Fig 50 Young ferns in the fern lab

Held within the offices of the NTBG, the fern laboratory is where the more delicate side of horticulture occurs. Consisting of two rooms which are under constant climate control, the fern lab is where spores are recorded and sown, gametophytes are grown and weeded and sporophytes are transplanted and protected.

Much like work in the herbarium, tasks in the fern lab were detailed, precise and long but with great results.

Much of our time in the labs was spent using dissection microscopes to weed out individual moss plants away from fern gametophytes using fine forceps. This most certainly developed our concentration and hand to eye coordination skills as well as the obvious patience levels.

Before sowing fern spores, sample pictures needed to be taken of the spores to check for presence and viability for future records. This was a skill in itself trying to line up tiny spores under the microscope in order to take pictures but one I developed quickly and enjoyed.



Fig 51 Plastic trays for fern gametophytes to develop



Fig 52-57 Pictures under the microscope of spores and spore capsules

## A DAY WITH THE KAUAI FOREST BIRD RECOVERY PROJECT



Fig 58 Alaka'i swamp trail

At the start of our internship were asked by our leader Ashly what we would like to do whilst we were there and Connor and I both said we would like to do as many varied activities as possible to gain as variety of different skills. To that end, Ashly arranged for us to spend a day with the team of the Kauai Forest Bird Recovery Project so that we could see the further benefits and impacts of plant conservation.

Led by Justin Hite, Field Crew Leader, we were driven to Koke'e State Park so that we could walk the Alaka'i swamp trail. It was explained to us that introduction of mosquitos to the island had had a real impact on bird populations as the mosquitos were spreading many diseases which were reducing bird populations. Due to this fact, a lot of the remaining bird populations had relocated to higher altitudes where the cooler air temperatures were not suitable for mosquitos.

Not for the faint hearted, this 8 mile hike takes you through some of the most amazing terrain and habitats with open environments and much more enclosed tropical ones.

It was amazing how the change in altitude changed the plant life so drastically.

Some of my favourite photos are from this day and worth being out breath for, for the majority of the day.



Fig 59 View from the vantage point overlooking the Wainiha Pali

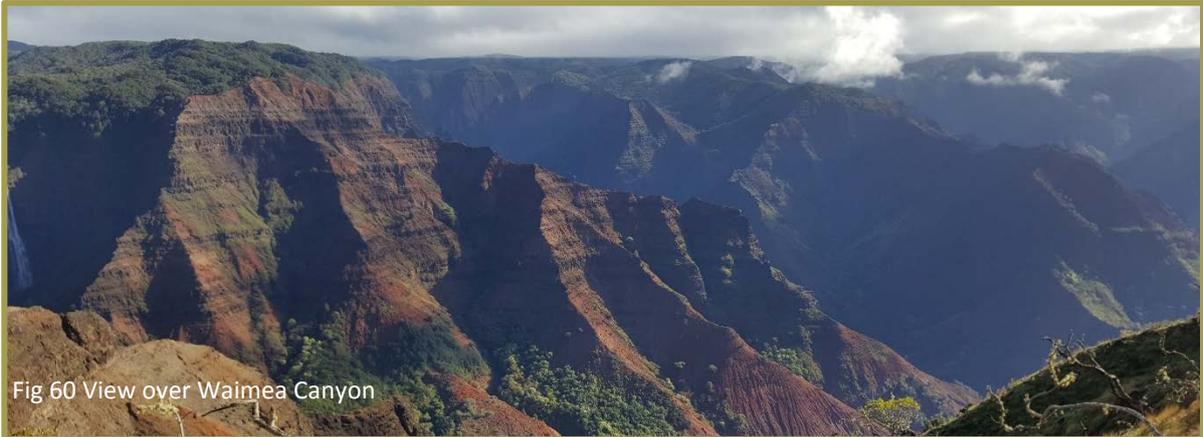


Fig 60 View over Waimea Canyon



Fig 61 Alaka'i Swamp Trail



Fig 62 Stream through Alaka'i Swamp Trail



Fig 63 Connor, Kama and I at the end of the hike

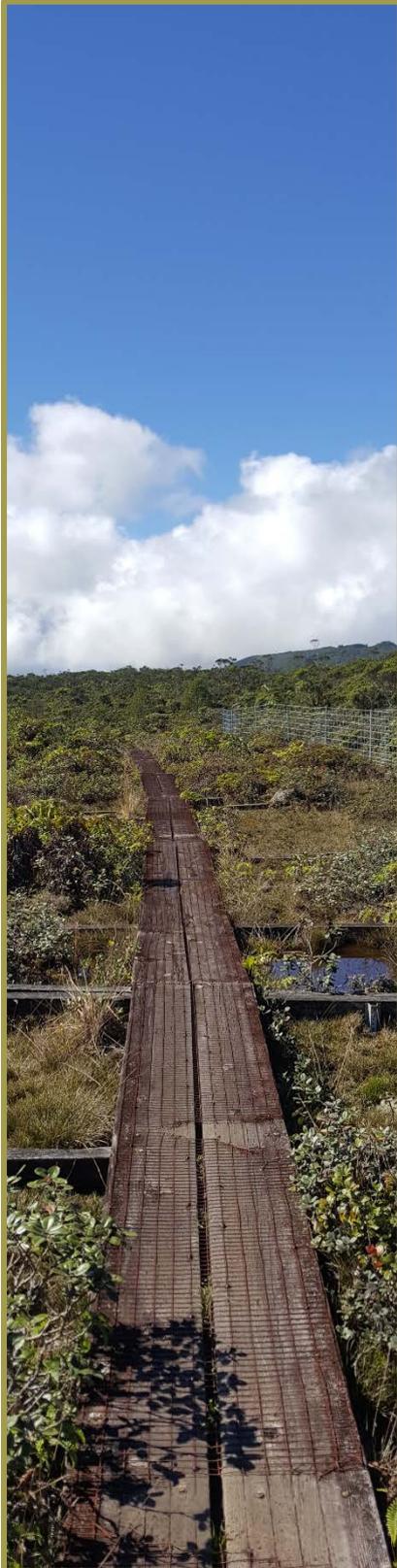


Fig 64 Alaka'i Swamp Trail



Fig 65 Alaka'i Swamp Trail

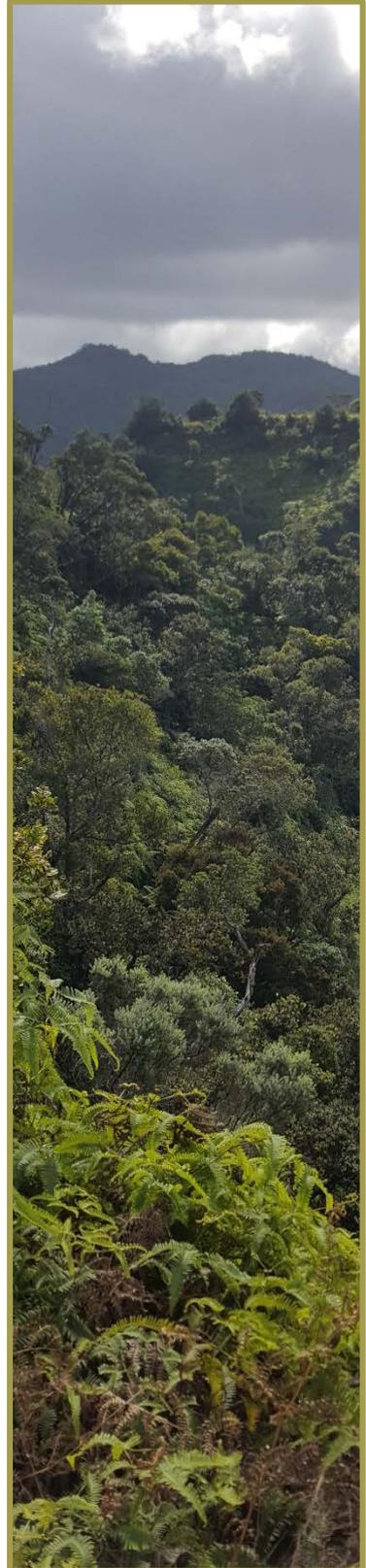


Fig 66 Alaka'i Swamp Trail

## THE CHOCOLATE FARM



Fig 67 Young *Thebroma cacao* trees at the chocolate farm in Waimea

One of our days out was spent visiting three growers of chocolate who were seeking the advice of Ashly Trask about propagation techniques and suitable irrigation systems for their farm.

Still in the early stages of growth, the attitudes towards farming of chocolate were very relaxed and treated much like a hobby. With that said, it is the hope of the small team to expand their workforce and use it as a youth outreach program to enrich and improve young people's lives through horticulture and horticultural training.

The team explained to us how young cacao trees prefer a more shaded environment and not be exposed to too much direct sunlight. To combat this, they plant banana trees around the young plants and once the cacao trees have matured more the banana trees are removed.

The team kept dogs on the farm in order to ward off wild boar which damage plants. Unfortunately, the dogs found a liking to the chickens that were being kept to try and control rose beetle (*Adoretus versutus*). This is definitely an example of a pest management system gone wrong.



Fig 68 Young cacao trees interplanted with banana trees



Fig 69 Ripening pods of cacao

On many of the young trees the damage caused by rose beetles is extensive and requires a strong pest management scheme if the damage is to be reduced in the future. As important as it is to learn what to do, sometimes it is just as important to learn what not to do and observe what happens when work is not conducted to a high standard. I imagine that in the future, with a larger work force, this situation will improve and so will the yield of the farm.



Fig 70 Damage caused by rose beetle on cacao plants



Fig 71 Soil at the chocolate farm

Although not the most interesting of pictures, it is simply to show the intense colour of the soil that covers the island. Kauai is famous for very vibrant deep red colour which should put anyone off wearing white whilst on the island. This colour comes from the fact that Kauai is one of the oldest Hawaiian Islands and it's highly iron rich, volcanic soils have had plenty of time to oxidize. In places, such as during the Alaka'i Swamp Trail, the water logged soils have turned grey due to lack of oxygen and leaching.

## THE LAWAI INTERNATIONAL CENTRE



Fig 72 The Hall of Compassion at The Lawai International Centre

The Lawai International Centre has been known as a healing site since the 1800's by both native Hawaiians and Asian immigrants. Both Taoist and Shinto temples were built here in the form of 88 miniature Shingon shrines which replicate an ancient pilgrimage route in Shikoku Japan.

On arrival, you are greeted with a smile, a piece of cake and a cup of jasmine tea before a presentation about the history of the site. We were told that although the site and shines had been there since the 1800's, by the 1960's the site was in a state of disrepair with much of it being overgrown.

Since then, thanks to the work of volunteers, the site has been cleared and a new temple named The Hall of Compassion was built in 2011 to replace the temples that were no longer standing. Whether you are a spiritual person or not, it is hard not to feel the relaxing and peaceful nature of the site with all who visit leaving rather 'zen'. It must have been the tea.

The restoration of this site is just another example of how important horticulture is and how it can influence so many people in positive ways.



Fig 73 Some of the 88 shrines



Fig 73 View of Shrine and over Lawai Valley



Fig 74 Shrines of the Lawai International Centre



Fig 75 Walking along the paths of the replica pilgrimage

## THE BREADFRUIT INSTITUTE



Fig 76 Breadfruit (*Artocarpus altilis*) trees at the NTBG

It is the mission of the breadfruit institute to promote the conservation and use of breadfruit for food and reforestation. We were taken on an introduction to the world of breadfruit by one of its members who taught us a lot of the basics.

Firstly, we spent time clearing fallen fruit that had over ripened. This fruit was in the most part unusable and was attracting pests so needed to be removed. A tally for each tree was taken to calculate productivity.

Once all of the unwanted fruit had been discarded, our next task was to search for fruit that had reached an appropriate level of ripeness (quite a task when many of the fruits are 10ft above your head). Of course it was raining heavily during all of this, so looking up towards the fruit was made more difficult, not a job for a fair weather gardener.

Once ripened fruit had been identified, a telescopic bypass tree pruner with a net attached to the end was used to harvest the fruit and stop it from becoming damaged by falling. Again these harvested fruits were counted in order to calculate tree productivity.

I had never heard of breadfruit or breadnut trees before my internship and the more I find out about them the more important I realise the work that the institute does is to the world.



Fig 77 Ripening breadfruit



Fig 78 Ripening Breadfruit

On approaching many of the breadfruit, they had, what appeared to be, bird excrement. This was in fact actually latex that had been excreted by the fruits and was usually an indication that the fruit was approaching ripening. Latex is present in all parts of the tree and has been used for glue, caulk, and even chewing gum but due to this fact it is near impossible to graft the tree.

*Artocarpus altilis* is an example of a monoicous plant (having both male and female flowers on the same plant). In this picture we see an example of one of the male flowers of the breadfruit tree. The male inflorescence are club shaped and typically 10cm to 45cm long, shedding pollen for about four days and attracting honeybees.



Fig 79 Male inflorescence of the breadfruit tree



Fig 80 Ripe fruit of Ulu (breadfruit)

Here we see an example of a ripened fruit which is ready to be harvested. The fruits of the breadfruit trees come in a diverse range of fruit shapes, colour and skin textures depending on the variety

## THE MOSSES OF HAWAII



Fig 81 Pleurocarpus Moss

Since studying horticulture, I have developed an interest in bryophytes with a focus on mosses. When reading about the biodiversity trail at the NTBG, I was intrigued to learn about their mist tunnel dedicated solely to moss.

One of the interesting things about the Hawaii is that there are so few species present on the island when compared to the rest of the world. A revised checklist of Hawaiian mosses was produced by Staples et al. in 2004 which showed that of the total 273 named taxa, 90 are endemic, 169 indigenous and 14 are referred to as alien. The percentage of non-native moss species is very small when compared to the level on non-native plants in the higher plant forms such as the angiosperms. This is due to mans impact upon the land and the introduction of ornamental species.

With an increasing interest in 'greening up' urban environments, improving office environments and a revived interest in terrariums, the study of bryophytes in tropical environments will become more pertinent and important.

Due to the fact that we took part in such a varied array of activities, it was not possible to spend as much time studying the mosses of Hawaii as I would have liked. To that end, it is my hope to return in the future and focus my work around the mosses.



Fig 83 Moss growing on a wall in the Allerton Garden



Fig 84 Kokedama in the moss tunnel

When speaking with Ashly Trask, I told her about some of the creative uses of mosses and she was particularly interested in the Japanese art of kokedama, with an example shown to the left. Coming from the Japanese koke, meaning moss, and dama, meaning ball, it is literally a moss ball that contains the roots of plant and was developed alongside the art of bonsai. This particular kokedama is no hung in the moss tunnel of the biodiversity trail to demonstrate the introduction of ferns in a different way.

One of the things I noticed was that the number of different species in the moss tunnel was rather limited. One of my aims whilst at the NTBG was to help develop the moss tunnel, so that is what I did. With permission, I collected samples of various mosses from around the NTBG and used them in propagation trials so that they may later be transplanted into the biodiversity trail. As moss grows slowly, I was unable to see any results whilst in Hawaii but I have been informed that since then, the mosses are doing very well and growing nicely.



Fig 85 Propagation trials of mosses at the nursery



Fig 86 Preparing kokedama materials

After producing my kokedama for Ashly, everyone was impressed and wanted to learn how to make them. From this the volunteer coordinator Evonne asked if I would be interested in teaching a few classes on how to make kokedama and a little about moss in general. I of course said yes and here is a picture of me preparing my materials ready for my class. It was great to spread my love of moss to others and chances to practice public speaking are always a benefit.



Fig 87 Kokedama Class



Fig 88 Kokedama Class



Fig 89 Kokedama Class

Fig 87 – 89 Photos from the second kokedama class I taught at the NTBG



Fig 90 A variety of kokedama that I made

Below is an email that was sent to Ashly Trask from the volunteer coordinator Evonne Revitt follow the first kokedama class I taught.

'Aloha Ashley,

Just wanted to let you know that Ben's workshop was a smashing success! He donated a few kokedamas and so did a few of the volunteers and we have sold all of those for \$10 each! Proceeds to the garden directly from Oshibana! Everyone loved them and thinks we should have them around the garden and for sale in the gift shop, I personally think we could sell them for more! I would love to have Ben back for another workshop. Everyone loves Ben and the Kokedamas! Please convey my thanks to Ben for a great workshop, he is awesome!

Best, Evonne'



Fig 91 A variety of Kokedama I made



Fig 92 Acrocarpous moss

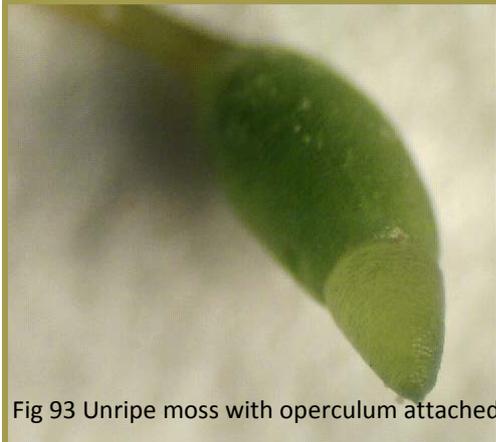


Fig 93 Unripe moss with operculum attached



Fig 94 Moss capsule with peristome teeth



Fig 95 vid capture, peristome teeth opening

I took the opportunity of using the facilities of the lab to examine more closely the mosses of Hawaii. Here are a few pictures of various moss species under the microscope at varying stages of development. This first picture shows the tip of an acrocarpous gametophyte. We can see here that the majority of the 'leaves' are only one cell thick and very translucent. With such small features, sometimes we really need to get up close to appreciate them.

Once the sperm from the tip of the antheridia (the male moss) fertilises the egg of an archegonia (female moss) the sporophyte develops consisting of a seta, a spore capsule and an operculum which protects the opening of the spore capsule whilst the spore fully develops. We can see here that the operculum is still attached to the capsule has not yet ripened.

Once ripened, the operculum falls away to reveal the peristome teeth which control the release of the spores in the capsule. With either one set or two sets of peristome teeth, the sporophyte uses varying moisture levels to control the release mechanism. In this picture we can also see small green structures covering the peristome teeth which are in fact the moss spores which are still tiny even at this level of magnification.

Whilst studying the mosses under the microscope I was able to open the peristome teeth with the use of water and a lamp to create different wet and dry environments. Once I had mastered this I was able to capture the teeth opening on the video recording equipment that the lab had for their microscopes. Here is a screen capture of that video which is available on youtube.

## SOCIAL MEDIA



Fig 96 Cliffs near to Maha'ulepu Beach

Social media is a great way to share your experiences, thoughts and general love for things. One of my aims from completing my internship with the NTBG was that I would inspire others to do the same. With the use of Twitter, Instagram and Youtube I have spread my experiences far and wide and many of the horticulture students in my present year groups and below are now seeking out similar experiences.



Fig 97 *Aristolochia grandiflora*

After posting my video of a moss spore capsule opening, it received 70 likes and 45 retweets from people all around the world.

This photo of an opened flower of an *Aristolochia grandiflora* in the McBryde Garden of the NTBG received 78 likes and 36 retweets over twitter worldwide. Im glad everyone loved the photo as much as I did.

By far the most popular on social media, this photo of *Gardenia latifolia* in the McBryde Garden of the NTBG received 111 likes and 49 retweets over twitter and is my most popular post to date.



Fig 98 *Gardenia latifolia*

## THESE ARE A FEW OF MY FAVOURITE THINGS



Fig 99 Ashly Trask the living rainbow in an actual rainbow in the moss tunnel of the biodiversity trail

During my month long internship with the National Tropical Botanical Gardens I took 989 photos which don't include the photos I took using the microscope. So far this report there have only been a tenth of these and now this section is dedicated to my most favourite photos and plants.

Photographs are an important part of documenting our experiences. As well as being objects of beauty, they help us remember important knowledge, skills and feelings that will help us in the future.



Fig 100 Statue in bamboo garden of the Allerton Garden



Fig 102 Moreton Bag fig trees



Fig 101 *Etlingera elatior*



Fig 103 *Aristolochia grandiflora*



Fig 104 Orchid of biodiversity trail



Fig 105 *Entada phaseloides*



Fig 106 Hanalei Pier

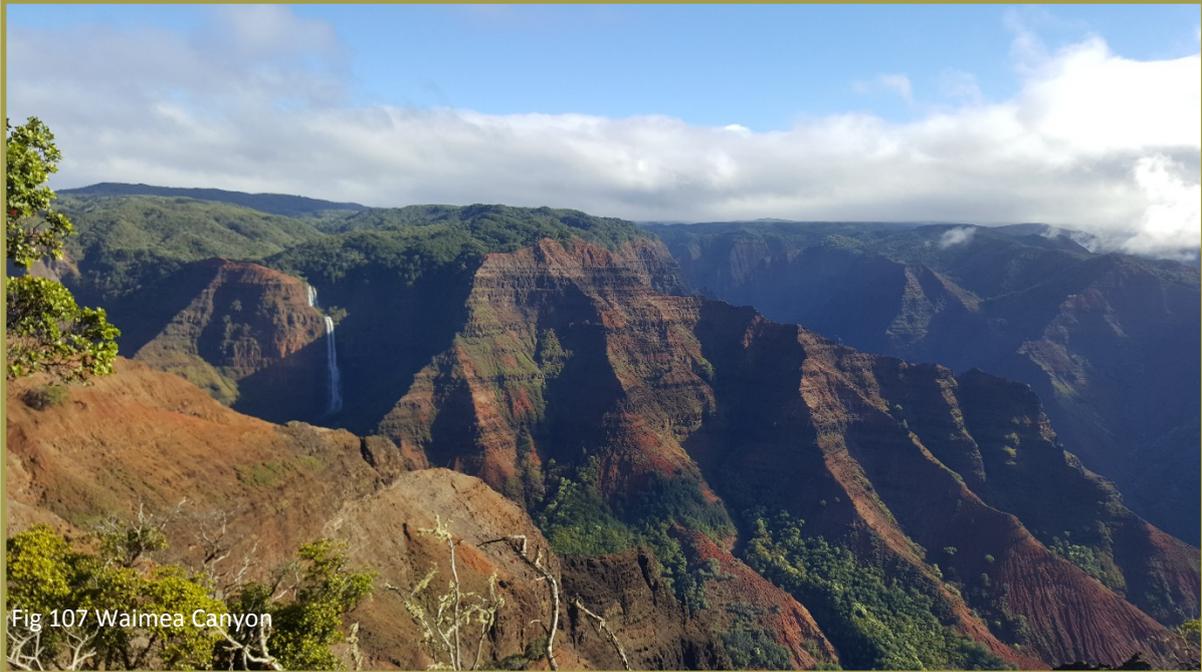


Fig 107 Wāimea Canyon



Fig 108 Christmas Day at the Trask residence



Fig 109 *Viola kauaiensis* endangered *Viola* native to Kauai



Fig 110 Seed head of *Nelumbo nucifera*



Fig 111 Leaves of the *Licuala naumannii* that naturally grow with this crimped affect at the end



Fig 112 'Birthday Palace' created by Patrick Dougherty in 2014



Fig 113 Contrast between light and shade in the McBryde Garden

## FINANCIAL BREAKDOWN

		INDIVIDUAL	COLLECTIVELY
<b>TRAVEL:</b>	AIR FARE	£ 739.85	£1479.70
	TRAIN FARE:	£ 88.80	£177.60
	CAR HIRE:	£ 0	
	FUEL:	£ 50	£100
<b>SUBSISTENCE:</b>	ACCOMMODATION:	£ 300	£600
	FOOD:	£ 600	£1200
<b>OTHER COSTS:</b>	VISA:	£ 0	
	INSURANCE:	£ 34.39	£68.77
<b>TOTAL</b>		<b>£1813.04</b>	<b>£3626.08</b>

## THANKS

It has already been said at the beginning of this report but it does bear repeating.

It is thanks to the charity of such organisations as The RHS, The Merlin Trust and The NTU International Scholarship scheme that opportunities such as these have been made possible and I hope that they equally benefit and enrich others' lives in the future as they have done mine.

I hope that you have enjoyed this report and that it has inspired you to visit the National Tropical Botanical Garden and other beautiful places around the world.

Many Thanks

Benjamin Chester